INCREASE PRODUCTION CAPACITY BY PERFORMING ASSEMBLY LINE BALANCING STUDY IN FOOD AND BEVERAGES MANUFACTURING

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BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY WITH HONOURS

2023

Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology with Honours

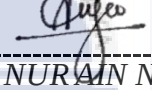
Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled "Increase Production Capacity By Performing Assembly Line Balancing Study In Food and Beverages Manufacturing " is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Engineering Technology with Honours.

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DEDICATION

To my late mother, father, siblings and friends who always give me inspiration and strength in terms of moral, emotional, and spiritual.

To my supervisor Ts. Dr. Amir Hamzah Bin Abdul Rasib, who always guiding, assisting and mentoring me in completing this thesis.

ABSTRACT

The manufacturing industry is experiencing rapid development and has progressed for the future. Any progress definitely comes with problems that need to be solved. A common problem faced by the industry is the imbalance of a bottleneck at each workstation. It is an issue that is underestimated by all industries including Food and Beverage Industries. A method such as Assembly Line Balancing (ALB) is one of the solutions to the problem. Typically, ALB is not used in the most efficient way possible. This is because the ALB method is still lacking in terms of infrastructure and technology to detect problems at workstations. Therefore, it will affect Work-In-Progress (WIP) which is considered an incomplete product. The objective of the study began by identifying the causes influencing the imbalance in the Assembly Line (AL) at the workstation. Next, the investigated causes help identify appropriate techniques for resolving task distribution imbalances at workstations. So, this technique will contribute ideas with respect to actions for the improvement of task time and WIP. The framework for this study is been planned and arranged based on a literature study related to ALB. The qualitative and quantitative approaches such as data collection are essential to complete the study. Interviews, image capture, and the arrangement of the form data for calculation and formulation were all used in the data collection process. An equation from cycle time to line efficiency is used based on the structure of ALB components. The result of the calculation is to find out which station is the most unbalanced. Then, Cause and Effect diagrams are been used to identify the incidence of loss factors and causes meanwhile the Why-Why Analysis used to make suggestions and ideas for improvement. Then, the study can be applied to the Food and Beverage Industry. Thus, the thesis that contains research about ALB will be beneficial and useful, especially to the manufacturing company that aims to increase production productivity.

ABSTRAK

Industri pembuatan mengalami perkembangan pesat dan kemajuan untuk masa hadapan. Sebarang kemajuan pasti hadir dengan masalah yang perlu diselesaikan. Masalah yang biasanya dihadapi oleh industri pembuatan ialah ketidakseimbangan kesesakan di setiap stesen kerja. Ia merupakan isu yang dipandang remeh oleh semua industri termasuk Industri Makanan dan Minuman. Kaedah seperti "Assembly Line Balancing" (ALB) adalah salah satu penyelesaian kepada masalah tersebut. Lazimnya, ALB tidak digunakan dengan cara yang paling cekap semaksimum mungkin. Ini kerana kaedah ALB masih kekurangan dari segi infrastruktur dan teknologi untuk mengesan masalah di stesen kerja. Oleh itu, ia akan menjejaskan "Work-In-Progress" (WIP) yang dianggap sebagai produk tidak lengkap. Objektif kajian dimulakan dengan mengenal pasti punca yang mempengaruhi ketidakseimbangan dalam "Assembly Line" (AL) di stesen kerja. Seterusnya, punca-punca yang diselidik membantu mengenal pasti teknik yang sesuai untuk menyelesaikan ketidakseimbangan pengagihan tugas di stesen kerja. Jadi, teknik ini akan menyumbangkan idea- idea berkenaan dengan tindakan untuk penambahbaikan masa tugas dan WIP. Rangka kerja kajian ini telah dirancang dan disusun berdasarkan kajian literatur yang berkaitan dengan ALB. Pendekatan kualitatif dan kuantitatif seperti pengumpulan data adalah penting untuk melengkapkan kajian. Temu bual, tangkapan imej, dan penjujukan borang data untuk pengiraan dan rumusan semuanya digunakan dalam proses pengumpulan data. Persamaan dari masa kitaran kepada kecepan talian digunakan berdasarkan struktur komponen ALB. Hasil pengiraan adalah untuk mengetahui stesen mana yang paling tidak seimbang. Kemudian, gambar rajah "Cause and Effect" digunakan untuk mengenal pasti berlakunya faktor dan punca kerugian manakala "Why- Why Analysis"digunakan bagi membuat cadangan dan idea untuk penambahbaikan. Justeru, tesis yang mengandungi penyelidikan tentang ALB ini akan bermanfaat dan berguna terutamanya kepada syarikat pembuatan yang bertujuan untuk meningkatkan produktiviti pengeluaran. Akhir sekali, tesis ini kemudiannya dibincangkan dan dibentangkan kepada wakil industri untuk dinilai.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform.

My utmost appreciation goes to my main supervisor, Ts. Dr. Amir Hamzah Bin Abdul Rasib, Universiti Teknikal Malaysia Melaka (UTeM) for all his essential assistance, support, and supervision in the completion of my thesis. His constant spirit to guide and provide priceless insights will forever be remembered. Thank you for always supporting my journey.

Last but not least, from the bottom of my heart gratitude to my beloved parent, Manap Bin Bujang and Salwa Binti Yunus, for their encouragements, love, and prayers and who have been the pillar of strength in all my endeavors. Even though my mother already passed away, she must be proud of me. Therefore, I dedicate this thesis to her. My family who always supported me in any situation and was always there for me. I would also like to thank my friends who together struggled to finish final year project. Thank you for always cheer me up. Finally, thank you to all the individuals who provided me the assistance, support and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

AL	-	Assembly Line
WIP	-	Work-In-Progress
ALB	-	Assembly Line Balancing
ALBP	-	Assembly Line Balancing Problem
SALBP	-	Simple Assembly Line Balancing Problem
GALBP	-	General Assembly Line Balancing Problem
ALB-UT	-	Assembly Line Balancing Uncertain Task
TPS	-	Toyota Production System
JIT	-	Just In Time
TPM	-	Total Preventive Maintenance
TQM	-	Total Quality Management
MMALB	-	Mixed-Model Assembly Line Balancing
MMAL	-	Multi-Model Assembly Line
F & B	-	Food and Beverages

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research Background

Assembly Lines (ALs) are now driven to competitive and demanding markets, requiring efficient design of their configurations. In an assembly line, the work components move down a succession of workstations, where distinct assembly activities are completed sequentially for the given operating period. The workstations in the assembly line have the same cycle time, which is a fixed work pace. The Assembly Line productivity is heavily influenced by the performance of the bottleneck workstation, which has the highest sum of processing time. As a result, every workstation's activity must be balanced to eliminate idle time and Work-In-Progress (WIP). Assembly lines are supposed to build such that duties are organized and assigned to work stations promptly, maximizing line efficiency. As explained by Chica (2016), Assembly Line Balancing (ALB), is a challenge that involves distributing tasks to workstations in a balanced manner.

Similarly, Salveson (1955), stated that the ALB problem (ALBP) aims to evenly divide and assign a number of jobs to several workstations while fulfilling precedence relationships and cycle time limitations, hence can optimizing one or more goals. ALBP is a classic NP-hard combinatorial optimization problem. The goal of ALBP is to assign jobs to workstations in the most efficient way possible while keeping some limits in mind. Bryton was the first to suggest the ALBP, while Salveson was the first to conduct scientific research on it. Readers can consult for a comprehensive overview of ALBP.

According to the number of product models, factor characteristics, assembly line styles, assembly line aims and restrictions, and so on, ALBP can be classified into many types. ALBP was divided into two categories which are simple ALBP (SALBP) and general ALBP (GALBP) according to Becker et al. (2006). Single-model assembly lines are used in SALBP, where the operation time of tasks is known as fixed and specific criteria must be met. It becomes GALBP when more constraints or elements are added to the problem, such as multi-models, stochastic task timings, and U-shaped assembly lines. Other than that, ALBP has uncertain task times (ABP-UT) which going a lot of traction in academia these days. The unstable of the operator's work rates, the diverse skills and motivations of workers, and the failure sensitivity of complex systems uncertainty can all contribute to task time uncertainty.

All of the problems have the same purpose or aim which is to meet the demand to establish the appropriate workstation-task assignment for identical and repetitive operations or activities by considering the requirement and cycle time. Any mass production system is primarily used for the product models. This approach necessitates uniformity and specialization for similar and repeatable operations. Therefore, establishing the best feasible workstation–task assignment by minimizing the number of workstations, improving the rate of production, and lowering the idle time between the workstation in the process is important for a mass-production system. Generally, a solution like a task duration and cycle time are commonly used in ALB models but sometimes real life on the other hand full of uncertainties because the annual demand of a product is really hard to predict nonetheless the decision-maker or production planned can utilize their judgment and experience to forecast annual demand for a bad and good situation. So, studying ALB can improve the decision-making for the manufacturing process of workstations and production process.

1.2 Problem Statement

An AL usually is made up of several workstations that are normally organized along a conveyor belt or other material handling equipment. Work is produced in sequential order along the line and transferred from one station to another. Some of the processes are repeated at each station to minimize the cycle time. Therefore, the problem that is commonly faced in the ALB is to entail distributing assembly work in the most efficient manner possible stated by Chica et al. (2016). The reason that may lead to this problem is the assembly line is unbalanced because it depends on the standard of the scheduling industry and documents that do not precisely follow the task time that has been given at each station.

Other than that, the problem that is happening in the assembly line is a Work-in-Progress (WIP). According to Koopmans and Beckmann (1957), WIP is considered an incomplete product. It is because the inventory may begin the production process but not finished the product or unfinished process as well as can not include in raw material. It will lead to waste and produce a low-quality product. These are crucial problems that need to be solved to improve the manufacturing process in workstations. The production will face needless buffers and product storage areas that cause a severe impact on the bottom line.

Lastly, the problem that damages the manufacturing assembly line is the lack of infrastructure and technologies to detect the problems at the workstation and assess the complete assembly line process from a single point as identified by Xu et al. (2016). It is because the weakness that has been pointed out may be hard to identify as soon as possible. The worker can not be able to forecast issues or problems and respond quickly if do not have reliable, continuing, real-time data about the latest assembly-line condition.

1.3 Research Question

Three research questions are identified based on the problem statement

RQ1: What are the causes of the unbalanced in the assembly line at the workstation?

RQ2: What is the suitable techniques or tools to solve the unbalanced distribution of tasks at workstations?

RQ3: How the improvement of task time and WIP can affect minimizing the number of workstations or production processes?

1.4 Research Objective

The main aim of this research is to increase the production capacity in the manufacturing industry by performing line balancing studies such as ALB. Regarding the primary objective, several specific objectives need to be accomplished in this study.

i. To identify the causes that affect the unbalanced in the Assembly line in the workstation
ii. To conduct ALB to solve the unbalanced distribution of tasks at workstations
iii. To improve task time and WIP for maximize the production processes

1.5 Research Scope

The scope of this study is focused on the ALB in the workstations. Next, study the techniques or tools using ALB to know the effectiveness of it to increase the production capacity in the manufacturing industry. The technique is implemented after collecting the data from the industries that have been chosen which are foods and beverages. ALB is been used because it can minimize the number of workstations as well as improve the task time and production process. As a result, all preparations should be made in order to meet the research's goal. The K-chart, as shown in Appendix A, is a method of systematically organizing research.

1.6 Expected Results

The expected outcome of this study is to figure out the factors that affected the balance of the Assembly line. By detecting the reasons, the predetermined aim can be achieved which can minimize the number of workstations, maximization of the production rate as well as task allocation of each worker. Thus, the task time and WIP automatically improved based on the study of the latest developments and trends available in the industries.

Next, the application of suitable methods can increase the productivity of production. For example, by using calculation of Cycle Time, calculation of an Efficiency Line, and also calculation to assigning tasks to the workstation. This is because it helps assignment of tasks to workstations, resulting in the optimal assignment. Thus, this research looks at how to line balancing and task sharing can improve the overall efficiency of a single model assembly line by eliminating bottlenecks.

1.7 Thesis Frame

The first chapter focuses on the introduction to the broader thesis. The study's specifics are detailed in the introduction section. Then, it is followed by the study's problem statement. A research question is produced based on the problem statement, which then allows the study's objective to be produced. Finally, after going over the objectives, a predicted result for the research project is created.

The literature review that was compiled for this study is discussed next in chapter two. This chapter enables you to collect, study, and comprehend past case studies and journals that are related to the study's title. Chapter two covers the elements that influenced the performance production capacity which is Lean, Lean Manufacturing, Lean Practice and

Different Manufacturing Industries, 8 Wastes of Lean Manufacturing, Assembly Line, Assembly Line Balancing (ALB), and a summary that summarize these topics. The writing style for this chapter will be based on previous findings from case studies, journals, and articles. As a result, several subtopics have been created t provide a detailed description of this research.

In addition, chapter three explains how the study is being carried out. Chapter 3 describes the tools and techniques that were used to perform the study based on past studies. The strategies and technologies that were employed in this study are described in full. These tools and techniques are used to solve problems and attain goals.

Following that, in Chapter 4, the results and analysis of the study will be presented. The tools and techniques mentioned earlier would be used to produce the results in this chapter. The method and types of tools used to gather data will be explored. As once data has been gathered, a discussion is held based on the findings to determine the impact of using the tools and techniques for this study.

To summarise, chapter five expresses the overall study's conclusion. To summarise, chapter five expresses the overall study's conclusion. This chapter also emphasizes future improvements for a better outcome. The introduction of an updated framework to smooth the production line is discussed in the future. Generally, the factors that influence performance are identified, analyzed, and then ALB is applied for development and the results are compared for future enhancement.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The manufacturing industry has been one of the important industries since the Industrial Revolution started. It is growing rapidly because many good products are being mass-produced. Products are applied to mass production that makes goods can be produced faster as well as more precision. Therefore, this will lower prices and bring the cost of numerous consumer goods into the reach of the general people. The manufacturing industry is shot up when the assembly line is introduced to the world. An assembly line is a logical arrangement of workstations centered on a conveyor belt or similar transportation system on which semi-finished products are transferred from one workstation to the next after a cycle time, and parts are assembled sequentially on it while meeting specific constraints until the final assembly is completed. After the product is finished, it is removed from the production line. Based on Tanenbaum and Holstein (2012), Henry Ford and his associates were the first ones to implement the assembly line manufacturing system concept of moving-belt transport in their automobile facilities. In 1913, they planned and controlled flywheel magnetos. This method takes the manufacturing industry to another level and paves the way for advancement and improvement to increase production capacity. Next, lean is normally practiced in the manufacturing industry. Womack et al. (1996) claimed that many businesses choose to embrace lean as a business approach. Lean concepts aim to cut lead times by eliminating non-value-added waste and delivering the remaining value-added processes to customers as rapidly as feasible. The ability to constantly enhance all processes is a crucial element of lean.

2.2 Lean Manufacturing

Lean is a management concept that is based on identifying and eliminating waste across the full value chain of a product as pointed out by Treville (2006). According to the citation, we can say that lean has become a widely accepted management paradigm, with applications ranging from industrial to Internet start-ups. So, lean has evolved and introduced lean manufacturing. Womack (1990) identified lean manufacturing as a theory that emphasizes utilizing less of everything. For example fewer materials, labor, time, and space than standard mass production. Lean manufacturing will eliminate procedures, processes, goods, or services that require time, resources, or expertise but do not add value to the client. Underexploited talent, excessive inventories, and poor or wasteful processes and procedures are examples of waste. Eliminating those bottlenecks can streamline production, lower prices, and essentially give advantages for a service or product to the client through the distribution network. The application of lean manufacturing can reduce and eliminate waste which at once can improve the productivity at the workstation. Other than that, it also can deliver customer value to the consumer in the long term. Below is the illustration of application lean tool in printing industry.

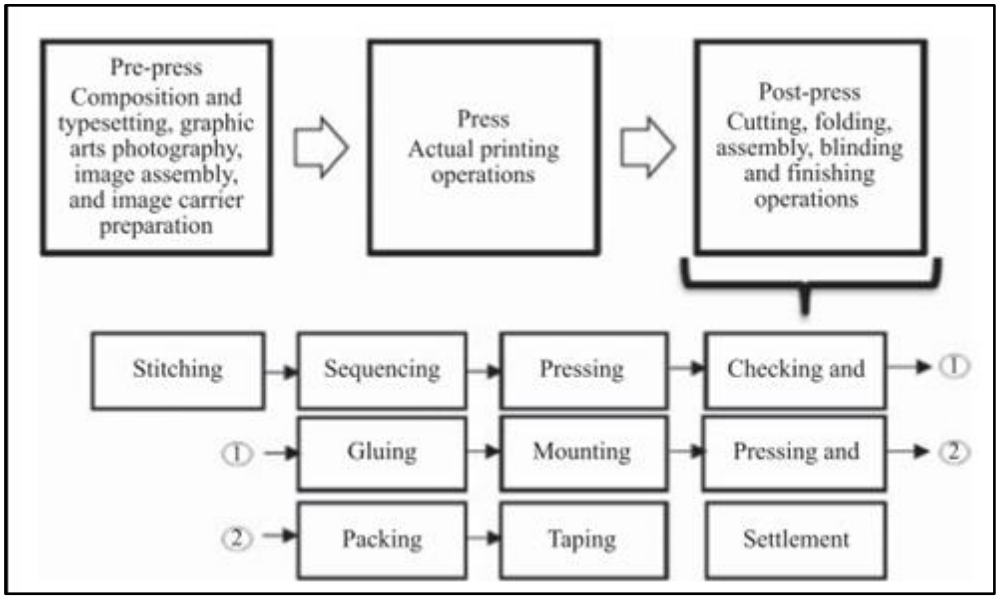

Figure 0.1 Application Lean Tool in Printing Industry (Boyer et al, 2018)

Manufacturing companies face several serious issues, including global ecological damage, resource waste and scarcity, pollution, and the indiscriminate exploitation of natural resources, all of which have a considerable impact on production costs according to Golroudbary et al. (2015). By using Lean Manufacturing, the problems that are commonly faced by companies will be removed. As identified by Maskell et al. (2006), Lean Manufacturing is the foundation for introducing current methods in manufacturing, services, and industries, as well as transitioning to a lean state, which involves changes in measurement, control, and accounting systems. As a result, traditional accounting and measurement systems must be replaced by lean accounting and measurement systems. Based on the explanation, it is triggered by new technologies in the manufacturing industry. Not just covered management but also control systems and machining. It should be remembered that introducing any new strategy, such as Lean Production, comes with its own set of challenges and obstacles. There is an important need to assess hurdles and propose strategies to overcome them. Toyota, a Japanese automobile manufacturer proposed tean Manufacturing in the 1950s under the name Toyota Production System (TPS). Their primary